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Change Pattern in Japan

(A Study on Change Detection of
Land Cover in Tokyo Districts
using Multi-dates LANDSAT CCT)

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Quarterly Report

**ORIGINAL CONTAINS
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*sent to
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A Study on Change Detection of Land
Cover in Tokyo Districts using Multi-dates
LANDSAT CCT

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1. Introduction

This report includes the present status of software developments for LANDSAT MSS CCT which have been completed in MURAI Laboratory, Institute of Industrial Science, University of Tokyo.

The objectives of the study are as follows:

- a. Geometric and geographic correction for high resolution LANDSAT digital data base.
- b. Establishment of environmental indicator for land cover and its color representation.
- c. Change detection of land cover in Tokyo Districts using multi-dates LANDSAT MSS CCT.

2. Techniques

2.1 Geometric and Geographic Correction for High Resolution LANDSAT Digital Data Base

Geometric and geographic correction for LANDSAT MSS CCT is accomplished as indicated as follows:

- a. Selection of control points
Twenty or thirty control points should be selected both on LANDSAT image plane and geographic map such as the national base map of 1:50,000. Coordinates of control points should be measured with the accuracy of unit of second for latitude and longitude on map and less than one pixel on image plane.
- b. Coordinate transformation between image coordinate system and map coordinate system
First to fifth order polynomials could be fitted by using least square method. From the analysis of accuracy, the third order polynomials will be sufficient which permit the variance less than a pixel RMS.

c. Establishment of Data Base

LANDSAT data is strongly required to be superposed on the existing map or other informations. Rearrangement of original data and interpolation for a new array of data base should be made.

The program developed enables the selection of the following frame and grid system;

Frame: a. Rectangular frame such as the national base map of 1:50,000.
b. Arbitrary polygons such as the boundary of local government
c. Circular frame such as Tokyo Districts within 50 kilometers radius.

Grid system:

a. Equal distance spacing such as 100 meters grid system.
b. Equal angle spacing for longitude and latitude respectively such as the national mesh system.

The software which can save the storage and computing time for establishing the above mentioned data base, has been developed.

Fig. 1 shows the example of rectangular frame of 1:50,000, Chiba area with 100 meters grid, which was made by DICOMED Color Printer.

Fig. 2 shows the example of polygons which represents the boundaries of Tokyo Prefecture, with 250 meters grid.

Fig. 3 shows the example of circular frame which represents Tokyo Districts within 50 kilometers radius, with 250 meters grid.

2.2 Establishment of Environmental Indicator for Land Cover and its Color Representation

Since the unit area of land use or land cover in Tokyo District is so small, even one pixel of LANDSAT MSS digital data of 57 meters by 76 meters includes a mixture of reflections from several different land covers.

A new conception should be introduced for the classification of land cover from such unresolved pixels, instead of the existing procedures such as clustering technique, maximum likelihood method, and so on.

Land cover is assumed by the author to be composed of a mixture of three primary components, water, vegetation and non-organic matter as shown in Fig. 4.

For example, residential district in the suburban area is composed of non-organic matter and vegetation. Turbid water is composed of water and non-organic matter.

Water, vegetation and non-organic matter and corresponded to the three primary colors, blue, green and red respectively.

From the statistical analysis on the correlation between LANDSAT digital data and land cover, the color index criteria which utilized band 5 and band 7 as the principal spectrum for color representation of land cover, has been established as shown in Fig. 5.

Fig. 6 shows the color representation of land cover in Tokyo Districts. In this figure, brown color represents the built up area with concrete and asphalt. Orange represents a mixture of more non-organic matter (red) and less vegetation (green) such as newly developed residential area or reclaimed land. Yellow green represents a mixture of more vegetation (green) and a little soil (red) such as golf course. Bluish green represents a mixture of more vegetation (green) and a little content of water (blue) such as forest.

Although these color representation is not the exact classification map with discrete color which corresponds to a specific land cover, one can extract more information from these representation, of which color has the specific meaning of the land cover composition.

2.3 Change Detection of Land Cover in Tokyo Districts using multi-dates LANDSAT MSS CCT

Geometric resistration for multi-dates LANDSAT MSS CCT can be made by the following two approaches.

- a. Transformation between multi-dates LANDSAT data
- b. Independent transformation from the respective LANDSAT data to geographically corrected data base.

In the usual case, the latter approach will be more useful for the subsequent application.

The program was tested for the following two LANDSAT-1 MSS data of two different dates, a portion of which is overlapped.

- a. Tokyo Districts; Nov. 26, 1972, ID. No. 112600484
C N35-53, E140-09
- b. Tokai Districts; Dec. 15, 1972, ID. No. 114500542
C N35-56, E140-14

Fig. 7a and b show the two LANDSAT image data base with 100 meters grid which corresponds to the national base map of 1:50,000, HACHIOJI. The figures show that the program enables the geometric and geographic registration with very high accuracy.

The following three modes can be selected in the program developed.

- a. Difference : $s=x-y$
- b. Variance : $v=y-(ax+b)$
- c. Ratio : $r=x/y$

Fig. 8 shows the change pattern which has been generated by using difference mode.

3. Accomplishments

Since any LANDSAT-2 MSS CCT is not yet available, change detection is not made between LANDSAT-1 data and LANDSAT-2 data. However, the ground surveys are now being made for the test area of Tama District where the rapid expansion of huge city, Tokyo is concentrated.

The following aerial photographs of 1:50,000 scale, 7500 meters altitude, have been taken in December, 1975, as the ground truth data of land cover.

- a. B&W aerial photography (visible)
- b. Aerial color photography with blue cut filter (Green and Red)
- c. B&W infrared with visible cut filter (IR)
- d. B&W infrared with green cut filter (Red and IR)

Preparation of the software has been completed for comming LANDSAT-2 MSS CCT.

4. Significant Results

- a. The software program, which enables the geographically corrected LANDSAT digital data base have been developed.
- b. The data base could be expected to provide land use planner with land cover information and the environmental change pattern.
- c. Land cover can be evaluated by the color representation which represents the ratio of mixture of three primary components, water, vegetation and non-organic matter.
- d. The software has been developed for the change detection between multi-dates LANDSAT MSS data.

5. Publications

The following two papers which were published by the author, and a book, as one of authors were referred in this report.

- (1) Shunji MURAI, Digital Correction of ERTS MSS Bulk Data for High Resolution Image Data Base, IVth International Symposium on Remote Sensing, Univ. of Tennessee, Apr. 1975.
- (2) Shunji MURAI, Evaluation of Land Use in Tokyo Districts and its Color Representation with LANDSAT Digital Data; IXth International Symposium on Remote Sensing of Environment, Ann Arbor, Nov. 1975.
- (3) Japan Association of Remote Sensing (JARS); Remote Sensing Notes; Gihodo.

6. Problems

- a. Optimum color representation for change pattern between multi temporal LANDSAT digital data should be investigated.
- b. Shaddow of mountain and water can not be delineated by the spectral digital data alone.

7. Data Quality and Delivery

Any LANDSAT-2 MSS CCT of Tokyo Districts with less than 10% cloud cover and its rapid delivery should be appreciated.

8. Recommendations

Full scene for LANDSAT imagery should be recorded in a CCT of 1600 BPI instead of four CCT, 800 BPI for quater strip of scene.

9. Conclusions

LANDSAT digital data could be data base of land cover which will be utilized in the national land information system for land use planning. More useful information concerning urban environment will be extracted if the multi-temporal LANDSAT data are available.

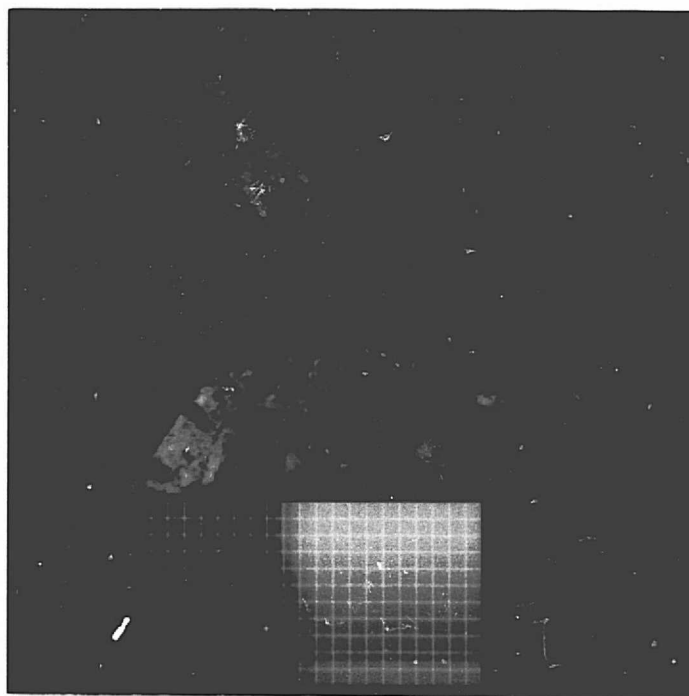


Fig. 1 Geographically corrected LANDSAT data base with 100 meter grids which corresponds to the national base map, 1:50,000, Chiba.

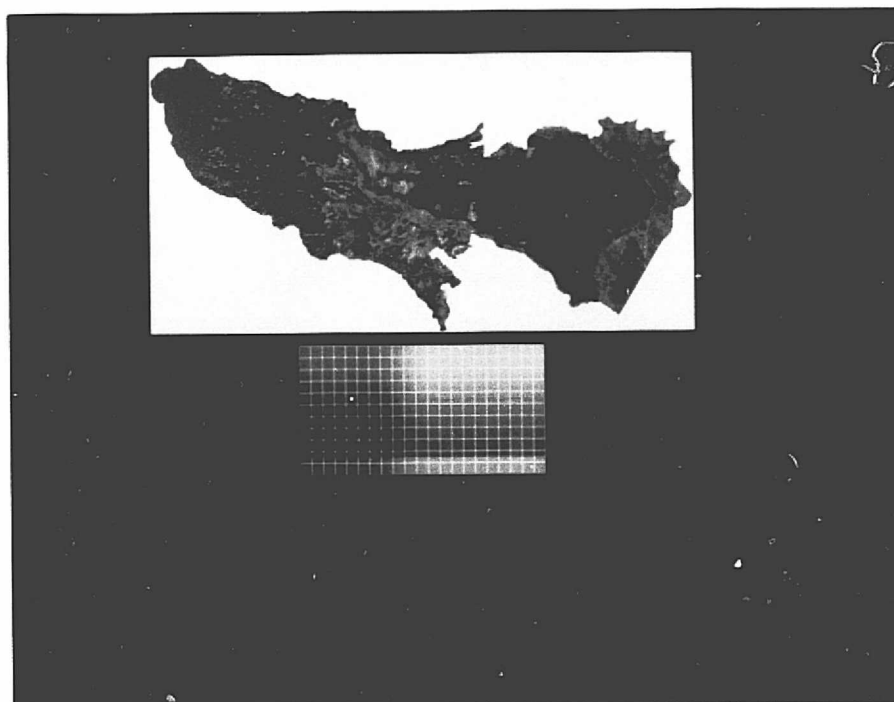


Fig. 2 Geographically corrected LANDSAT data base with 250 meter grids, Tokyo Prefecture.

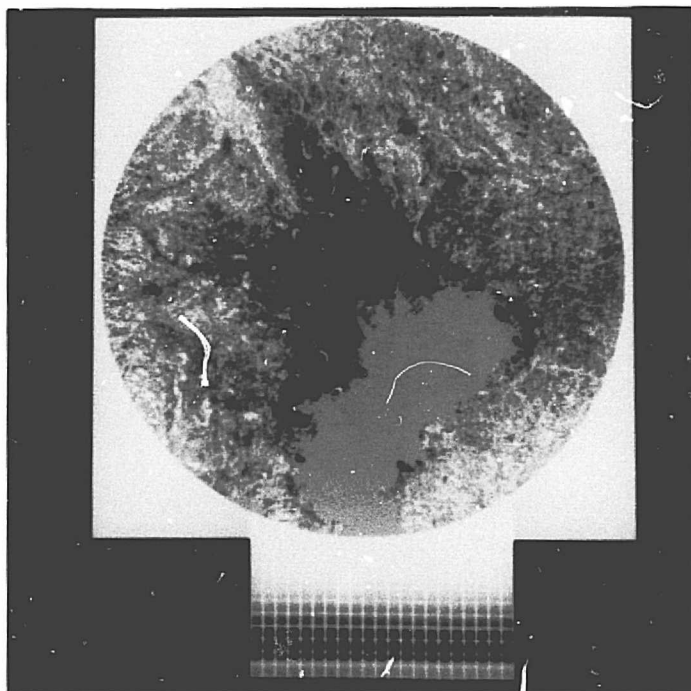
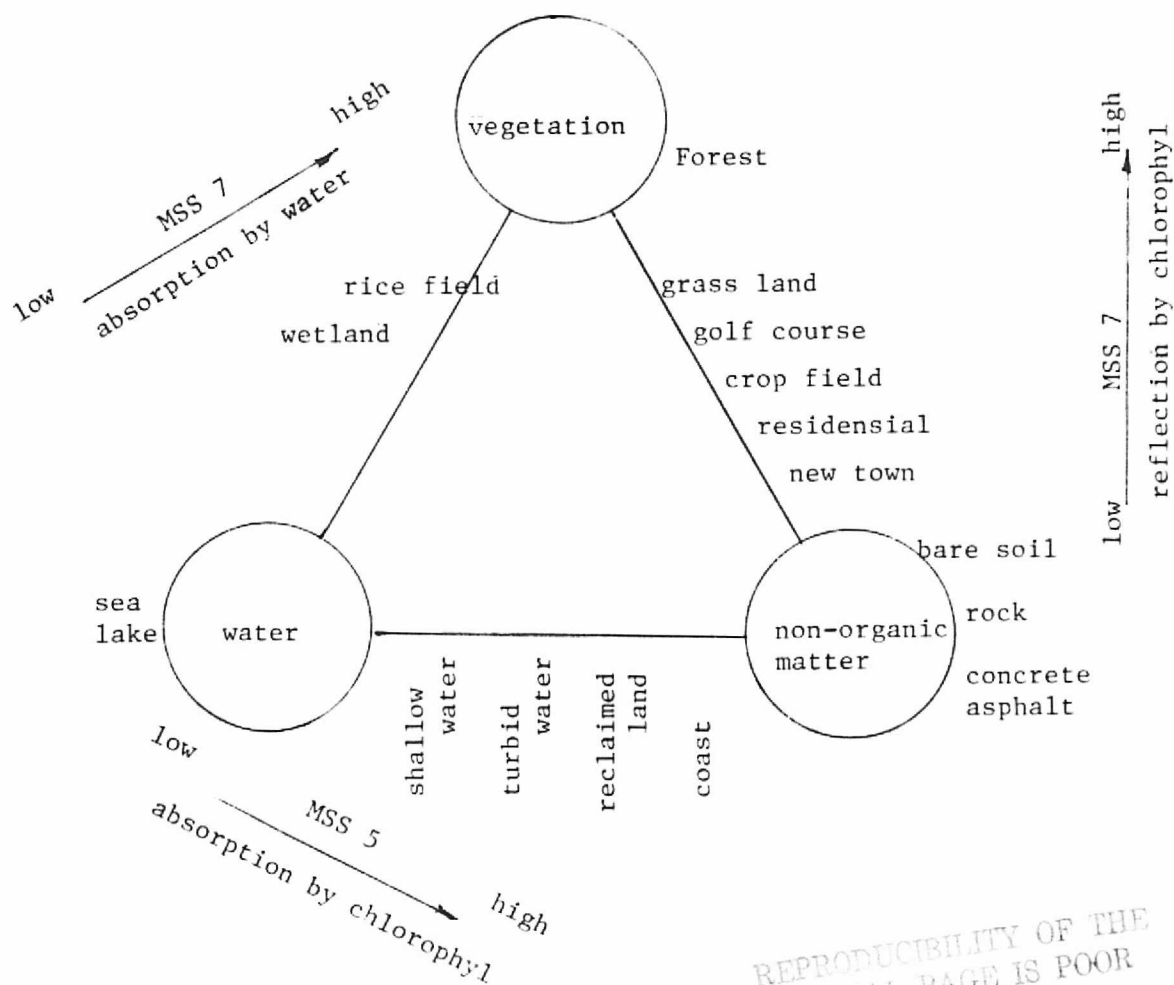


Fig. 3 Geographically corrected LANDSAT data base within 50 kilometers radius.



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Fig. 4 Three primary components of land cover.

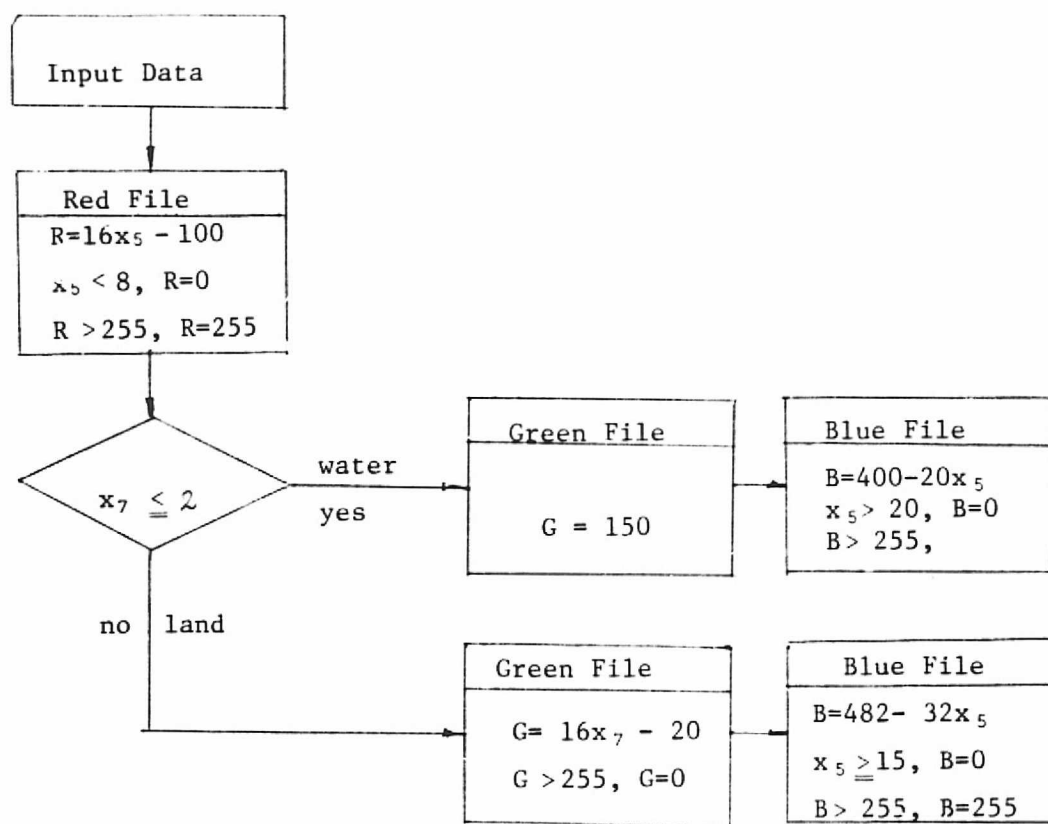


Fig. 5 Color index criteria for color representation of land cover.

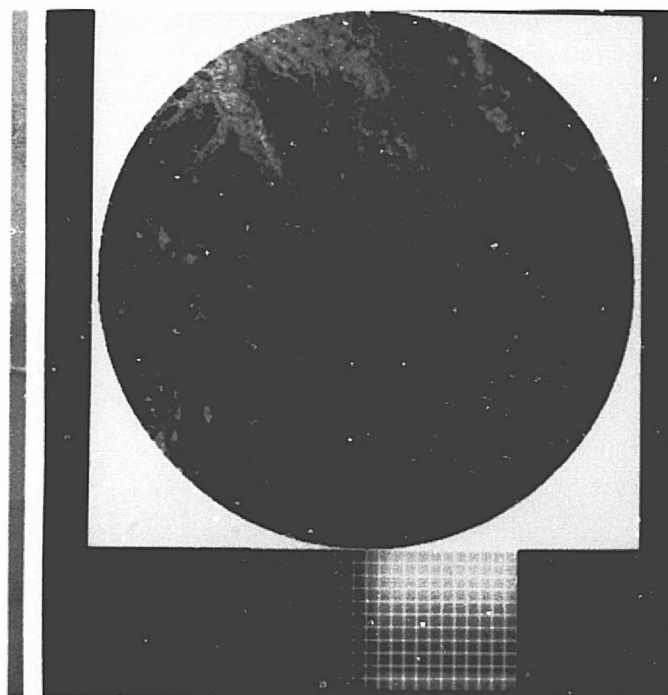


Fig. 6 Color representation of land cover in Tokyo Districts.

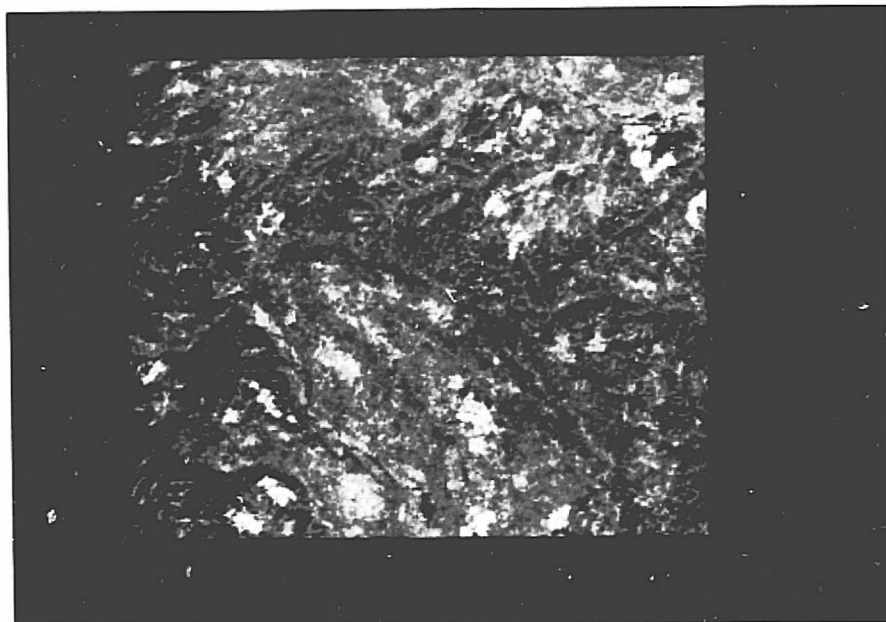


Fig. 7a LANDSAT data base, HACHIOJI, Nov. 26, 1972

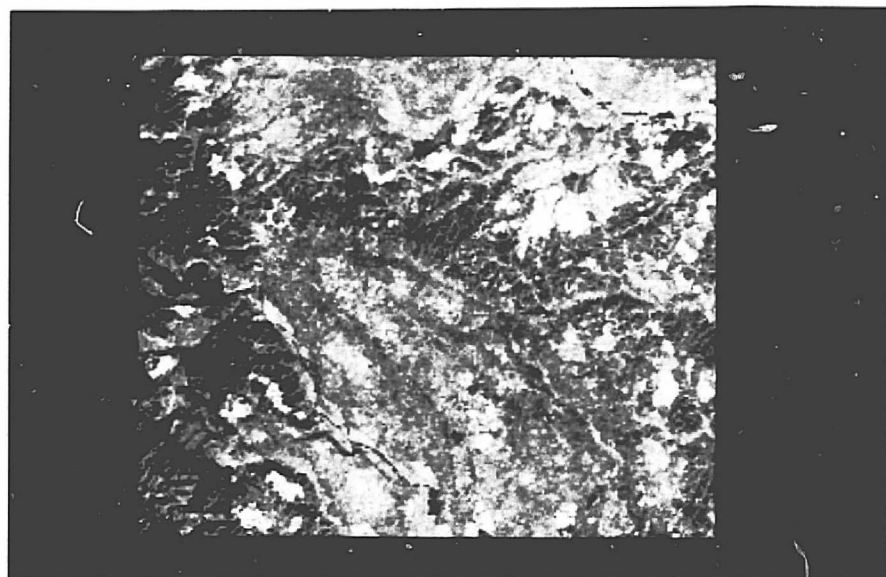


Fig. 7b LANDSAT data base, HACHIOJI Dec. 15, 1972

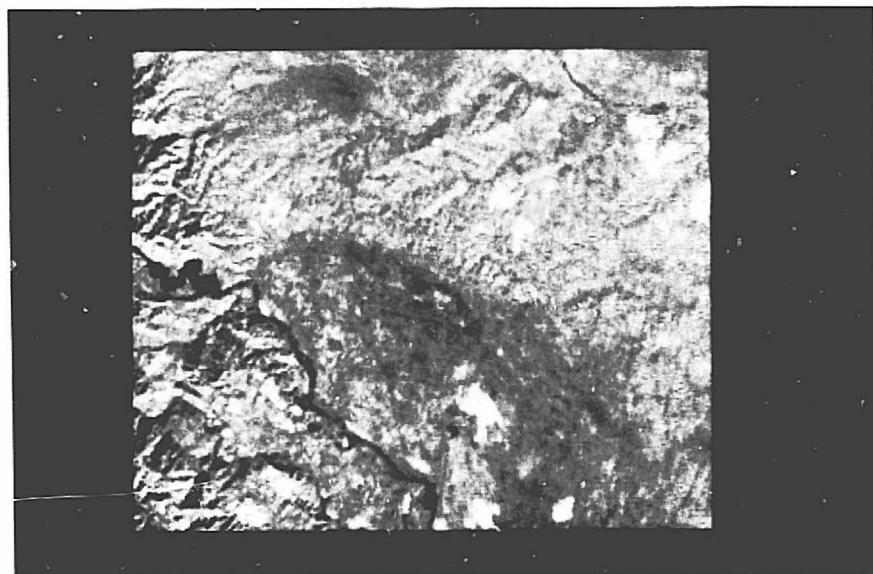


Fig. 8 Difference of multi-date LANDSAT data
between Nov. 26, 72 and Dec. 15, 1972.